
Kotlin

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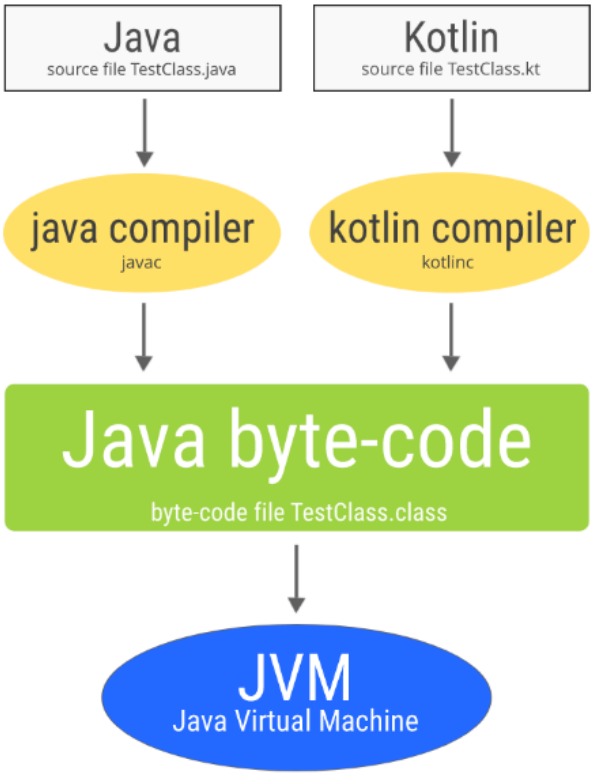
Declaring Variables

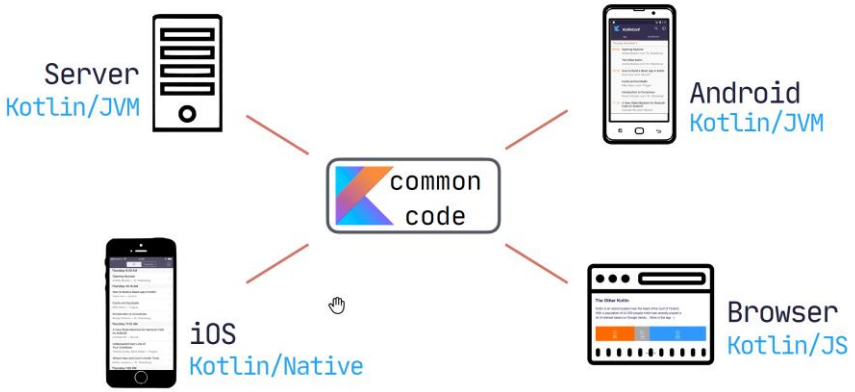
Highlights of Kotlin

- Statically typed language: Type **validation** at compile time
- Supports **Type Inference:** type automatically determined from the context
- Much more concise and readable code than Java
- Runs on Java JVM
  - Interoperable with Java code + libraries
  - But can also be compiled to JavaScript and iOS Swift
- Both **functional** and **object-oriented**
- Started in 2011 by JetBrains
  - Kotlin v1.0 was released on 15 February 2016
  - On 7 May 2019, Google announced that the Kotlin as its preferred language for Android app development
  - Current version 1.5.20 (released 24 June 2021)

How does it work after all?



Can target other platforms



val vs. var

- **val** is **immutable** (read-only) and you can only assign a value to them exactly one time
- **var** is **mutable** and can be reassigned

```
// val means final - cannot change once initialized
val name = "Ali"
val c: Int
c = 1

//Mutable - can be changed
var x = 5
x += 1

/* Type is auto-inferred - The variable datatype is derived
from the assigned value */
val city = "Doha"
```

Main Data Types

- Integer types: Byte, Short, Int, Long
- Unsigned integers: UByte, UShort, UInt, ULong
- Floating-point types: Float, Double
- Boolean
- Char
- String
- Any (equivalent to Object in Java)

Strings

```
//Strings and String Template
val firstName = "Ali"
val lastName = "Faleh"
```

- **String Template** allow creating dynamic templated string with placeholders (instead of string concatenation!)
  - Simple reference uses **$** and an expression uses **${}**

```
val fullName = "$firstName $lastName"
val sum = "2 + 2 = ${2 + 2}"

//Multiline Strings
val multiLinesStr = """
  First name: $firstName
  Last name: $lastName
"""
```

Convert a number to a string

- Use number's ***toString*** method

```
val num = 10
val str = num.toString()
```

Convert a string to a number

- Use string's ***toInt*** method

```
num = str.toInt()
```

Smart Cast

```
var myVar: Any = "Ali"
//Smart auto-cast
if (myVar is String) {
    println(myVar.last())
}
```

Nullable Types

- By default variables in Kotlin are **non-nullable**
- Nullable variables are declared **explicitly** to accept a null using **?** after the data type
- **Syntax:**

```
val iCannotBeNull = "Not Null"
val iCanBeNull: String? = null
```

- `val nullableName: String = null`
  - Compilation Error: Can't assign null to a non-null String
- `val nullableName: String? = null`
  - Compiles ok

Null Safety

- Safe calls:

Safe accessor (?)

```
val len = if (name != null) {
      name.length
}
```

```
val len =  name?.length
```

- Chaining:

```
student1?.department?.head?.name
```

- **Elvis Operator (?:)**

```
val len = if (name != null) name.length else 0
// Better syntax is to use the Elvis operator (?:)
val len = name?.length ?: 0

// !! means access it as non-null and throw an exception is null
val len = name!!.length
```

Best way for Null Safety

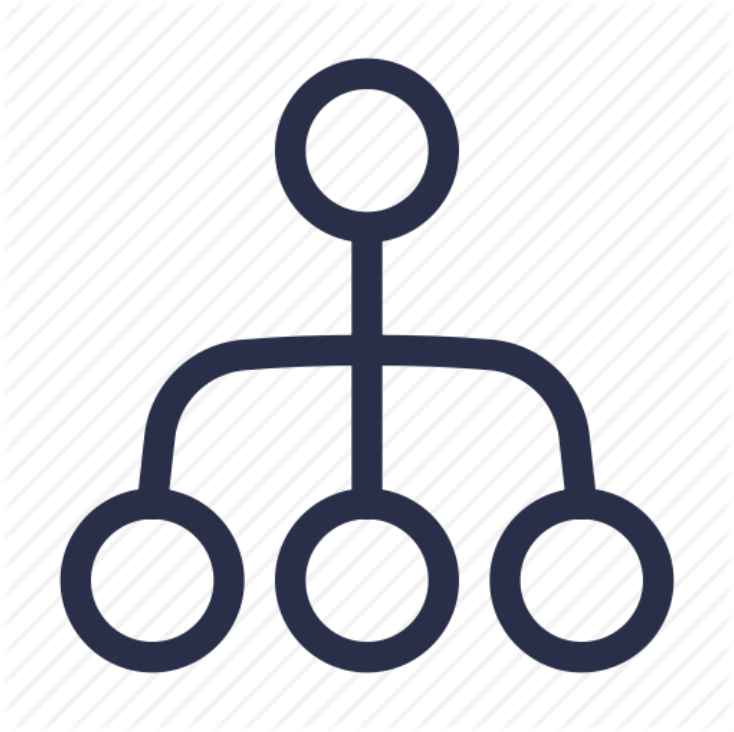
```
val name : String? = "Ali"
// ** Best 👍 ** : Checking for null using the 'let' operator
// The 'let' block only executes if 'name' is not null
name?.let {
    // 'it' is the non-null value stored in 'name'
    println("$it is not null")
}
```

Comments

```
// slash slash line comment

/*
 slash star
 block comment
*/
```

Control Flow: if, when expressions



if-else expression

```
val age = 20

// Using 'if' as an expression
val ageCategory = if (age < 18) {
    "Teenager"
} else {
    "Young Adult"
}
```

When expression

- Assign a value based on matching condition

```
val month = 8
val season = when (month) {
    12, 1,2  -> "Winter"
    in 3..5 -> "Spring"
    in 6..8 -> "Summer"
    in 9..11 -> "Autumn"
    else -> "Invalid Month"
}
```

Equals & reference equality

```
val set1 = setOf(1, 2, 3)
val set2 = setOf(1, 2, 3)
```

calls equals

```
set1 == set2
```

true

checks reference equality

```
set1 === set2
```

false

- `===` return true only if both variables hold a reference to the same object

while (…)
do { … }
for { … }
Loops

Execute Blocks of Code Multiple Times

While Loop

- While Loop:

```
while (condition) {
    statements
}
```

- Do-While Loop:

```
do {
    statements
}
while (condition)
```

for Loop Example

```
val names = listOf("Sara", "Fatima", "Ali")

for (name in names) {
    println(name)
}

// Loop with index and value
for ( (idx, value) in names.withIndex()) {
    println("$idx -> $value")
}
```

Ranges

- Usually defined by: `1..100`
- `1 until 100 // Range excludes 100`
- Negative step: `100 downTo 40`
- Decrement by 3

```
100 downTo 40 step 3
```

Caution!

```
val notArange = 100 to 40
// => Pair(100, 40)
```

- To check if a value belongs to the range:

```
val is5inRange = 5 in range
```

Ranges

```
if (i in 1..10) { // 1 <= i && i <= 10
    println(i)
}
```

```
for (i in 1..4) print(i) // "1234"
```

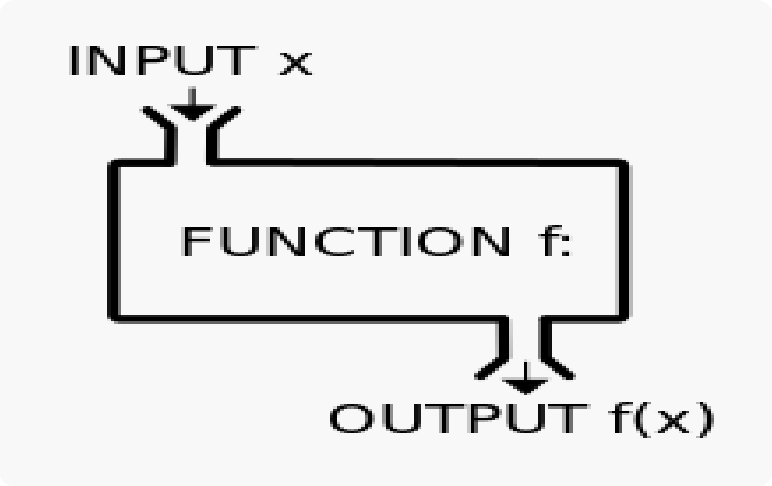
```
for (i in 4..1) print(i) // No Output
for (i in 4 downTo 1)
    print(i)             // "4321"
```

```
for (i in 1..4 step 2) print(i) // "13"
```

```
for (i in 4 downTo 1 step 2)
    print(i)                    // "42"
```

```
// i in [1, 10), 10 is excluded
for (i in 1 until 10) {
    println(i)
}
```

Functions



Functions

- Can be declared at the **top level** of a file (without belonging to a class)
- Can have a **block or expression body**
- Can have default parameter values to avoid method overloading
- Can used **named** arguments in a function call

```
fun max(a: Int, b: Int): Int {  //name - parameters - return type
    return if(a>b) a else b     //function block body
}

fun max(a: Int, b: Int) = if(a>b) a else b //expression body

max(a = 1,b = 2) //call with named arguments
max( a: 1, b: 2)
```

Functions

```
// Function with block body
fun sum(a: Int, b: Int): Int {
    return a + b
}

// Function with expression body
// Omit return type
fun sum(a: Int, b: Int) = a + b

//Arrow function - called Lambda expression
val sum = { a: Int, b: Int -> a + b }
```

Unit return type

- When defining a function that doesn't return a value, we can use **Unit** as the return type (Unit is equivalent to void in Java)
  - Specifying Unit as a return type is NOT mandatory can omit it

```
fun display(value : Any) : Unit {
    println(value)
}
```

Use default parameters instead of overloads

```
fun print() {
    print(",")
 }

 fun print(separator: String) {
 }

fun main() {
      print("|")
}
```

```
fun print(separator: String = ",") {
}

fun main() {
  print(separator = "|")
}
```

Extension Function

- Enable adding functions and properties to existing classes

```
// Extension method extending Int class
fun Int.isEven() = this % 2 == 0

fun main() {
    val num = 10
    println("Is $num even: ${num.isEven()}")
}
```

Extension Function Example

```
fun String.lastChar() = this.get(this.length - 1)
```

this can be omitted

```
fun String.lastChar() = get(length - 1)
```

Infix function calls

- Functions marked with the infix keyword can be called using the infix notation (omitting the dot and the parentheses for the call)
- Infix function must satisfy 3 requirements:
  - Must be member function or extension function.
  - Must have a single parameter.
  - The parameter must not accept a variable number of arguments

```
infix fun Int.add(b : Int) : Int = this + b

fun main() {
    val x = 10.add(20)
    val y = 10 add 20    // infix call
}
```

Exceptions

- Throw:

```
throw Exception("Invalid input")
```

- Handling

```
try {
}
catch (e: Exception) {
}
finally {
}
```

- Expression

```
val num = try { input.toInt() }
          catch (e: NumberFormatException){ null }
```

OOP

Java Class vs. Kotlin Class

```java
public class Person {
  private final String name;
  private final int age;

  public Person(String name, int age) {
    this.name = name;
    this.age = age;
  }

  public String getName() {
    return name;
  }

  public int getAge() {
    return age;
  }
}
```

```
person.getName()
```

Concise primary constructor

```kotlin
class Person(
    val name: String,
    val age: Int
)
```

```
person.name
```

Class

```
class Person(val firstName: String,
    val lastName: String,
    val age: Int) {
  val fullName: String
      get() = "$firstName $lastName"
  fun isUnderAge() = age < 18
}
```

Properties

- **Instantiate:**

```
val student = Person ("Fatima", "Ali", 18)
```

- **Named arguments:**

```
val student = Person (firstName = "Fatima",
lastName = "Ali", 18)
```

Properties are directly accessible without getters / setters

- val – read only properties
- var – read/write properties
- The primary constructor **cannot** contain any code.

```
class Person(val firstName: String,
    val lastName: String,
    var age: Int) {
  val fullName: String
      get() = "$firstName $lastName"
  fun isUnderAge() = age < 18
}
val student = Person ("Fatima", "Ali", 18)
student.age = 20
```

Class with a computed property

```
class Rectangle(val height: Int, val width: Int) {

    val isSquare: Boolean
        get() {
            return height == width
        }
}
```

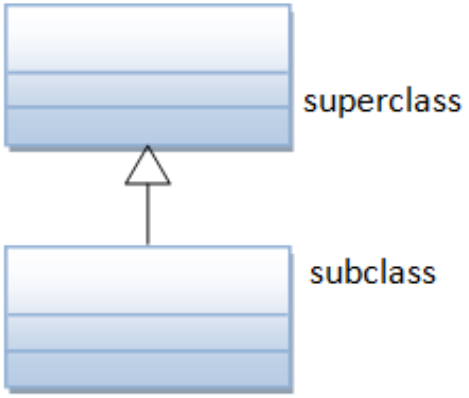
Secondary Constructor

```
class Conference(val name: String,
                 val city: String,
                 val isFree: Boolean = true) {
    var fee : Double = 0.0

    // Secondary Constructor
    constructor(name: String,
                city: String,
                fee: Double) : this(name, city, false) {
        this.fee = fee
    }
}

fun main() {
   al conference = Conference("Kotlin Conf.", "Doha", 200.0)
}
```

Inheritance

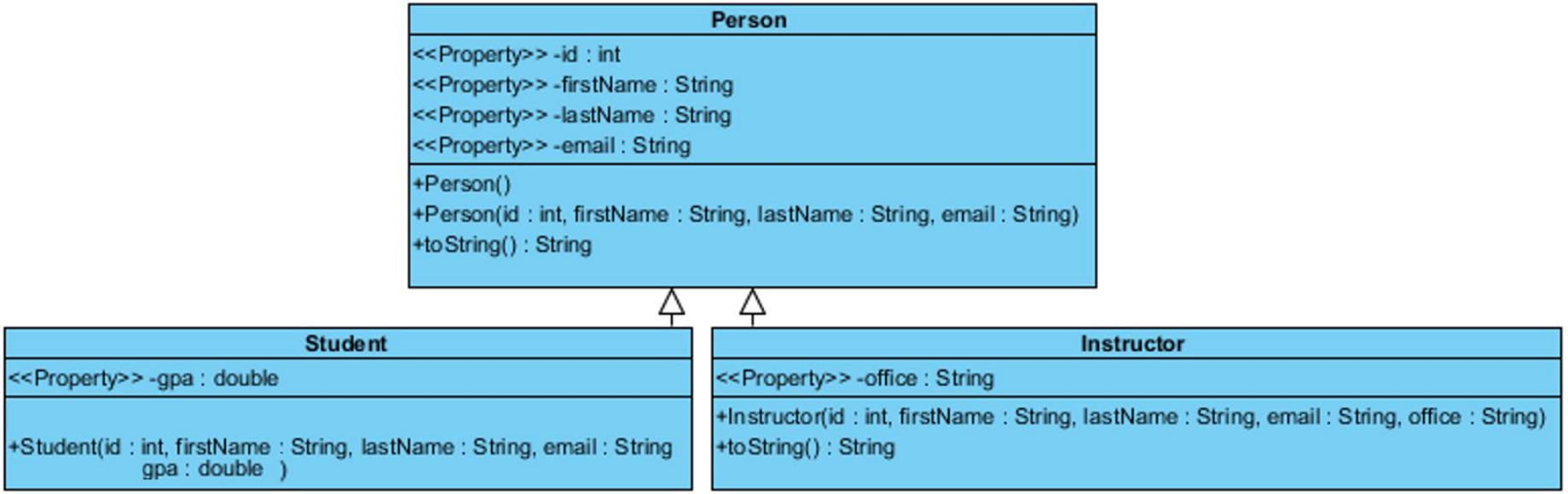


- **Ideas**
  - Common properties and methods are place in a **superclass** (also called ***parent class*** or ***base class***)
  - You can create a subclass that **inherits** the properties and methods of the super class
    - Subclass also called ***child class*** or ***derived class***
  - Subclass can extend the superclass by adding new properties/methods and/or overriding the superclass methods
- **Syntax**

```
class SubClass( … ) : SuperClass( … ) { … }
```

- **Motivation**
  - Allow **code reuse**. **Common properties and methods are placed in a super class** then inherited by subclasses (i.e., avoids writing the same code twice to ease maintenance)

Inheritance – Person Example



- The Person class has the common properties and methods
- Each subclass can add its own specific properties and methods (e.g., `office` for Instructor and `gpa` for Student)
- Each subclass can **override** (redefine) the parent method (e.g., Instructor class overrode the toString() method).

Inheritance – Person Example

```
open class Person( ... ) { ... }

class Student(firstName: String,
              lastName: String,
              age: Int,
              val gpa: Double
             ) : Person(firstName, lastName, age) {

    /*
     - Override a base class method
     - super keyword to call the implementation of the base class
    */
    override fun toString() = "${super.toString()}. GPA: ${gpa}"
}
```

- Add **open** keyword to the base class and to properties and methods to be overridden

Data Classes

- Data classes provide autogenerated implementations of **equals()**, **hashCode(), copy()** and **toString()** methods

```
data class User(val name: String, val age: Int)
val ali = User(name = "Ali", age = 18)

//Copy:
val olderAli = ali.copy(age = 19)

//Destructuring
val (name, age) = ali
// prints "Ali, 18 years of age"
println("$name, $age years of age")
```

Use ‘copy’ method for data classes

```
class Person(val name: String,
             var age: Int)

fun happyBirthday(person: Person) {
    person.age++
}
```

```
data class Person(val name: String,
                  val age: Int)

fun happyBirthday(person: Person) =
    person.copy(
        age = person.age + 1)
```

object = singleton

- Once instance for the whole app

```
object Util {
    fun getNumberOfCores() = Runtime.getRuntime().availableProcessors()

    val randomInt: Int
        get() = Random().nextInt()
}

fun main() {
    println(Util.getNumberOfCores())
    println(Util.randomInt)
}
```

No static keyword -> altenatives

- **Top-level** functions and properties
  (e.g. placed outside the class)
- **Companion objects:** special object inside a class to place static properties and methods
- **object** declartion used to create a **Singleton** (i.e., a single instance for the whole app):
  - Used for declaring the class
  - And providing a single instance of it

```
class Foo {
    companion object {
        fun bar() {
            //...
        }
    }
}

object Singleton {
    fun doSomething() {
        //..
    }
}


Foo.bar()

Singleton.doSomething()
```

Abstract Classes

- Idea
  - Use an abstract class when you want to define a **template** to guarantee that all **subclasses** in a hierarchy will have certain common methods
  - Abstract classes can contain implemented methods and **abstract methods** that are NOT implemented
- Syntax

```
abstract class SomeClass() {
    fun abstract method1(…): SomeType // No body
    fun method2(…): SomeType  { … } // Not abstract
}
```

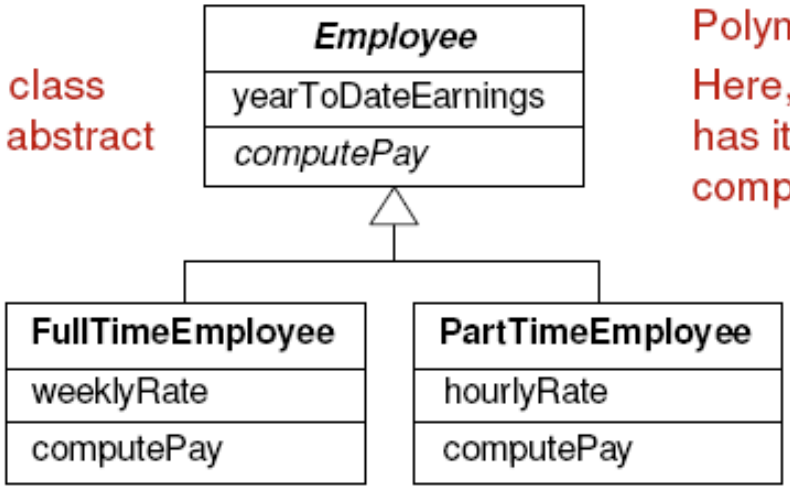
- Motivation
  - Guarantees that all subclasses will have certain methods => **enforce a common design**.
  - Lets you make collections of mixed type objects that can processed polymorphically

Abstract Classes

- An abstract class has one or more abstract properties/methods that subclasses MUST override
  - Abstract properties/methods do not provide implementations because they **cannot be implemented in a general way**
- An abstract class cannot be instantiated

Abstraction:

Employee is an abstract class and *computePay()* is an abstract operation (italicized)



Polymorphism:

Here, each type of Employee has its own version of computePay()

Abstract Class Example

Shape.kt

```
abstract class Shape {
    abstract val area: Double
    open val name: String
        get() = "Shape"
}
```

Rectangle.kt

```
class Rectangle(val width: Double,
                val height: Double) : Shape() {
    override val area: Double
        get() = width * height

    override val name: String
        get() = "Rectangle"
}
```

Circle.kt

```
class Circle(val radius: Double) : Shape() {
    override val area: Double
        get() = Math.PI * radius.pow(2)

    override val name: String
        get() = "Circle"
}
```

Interfaces

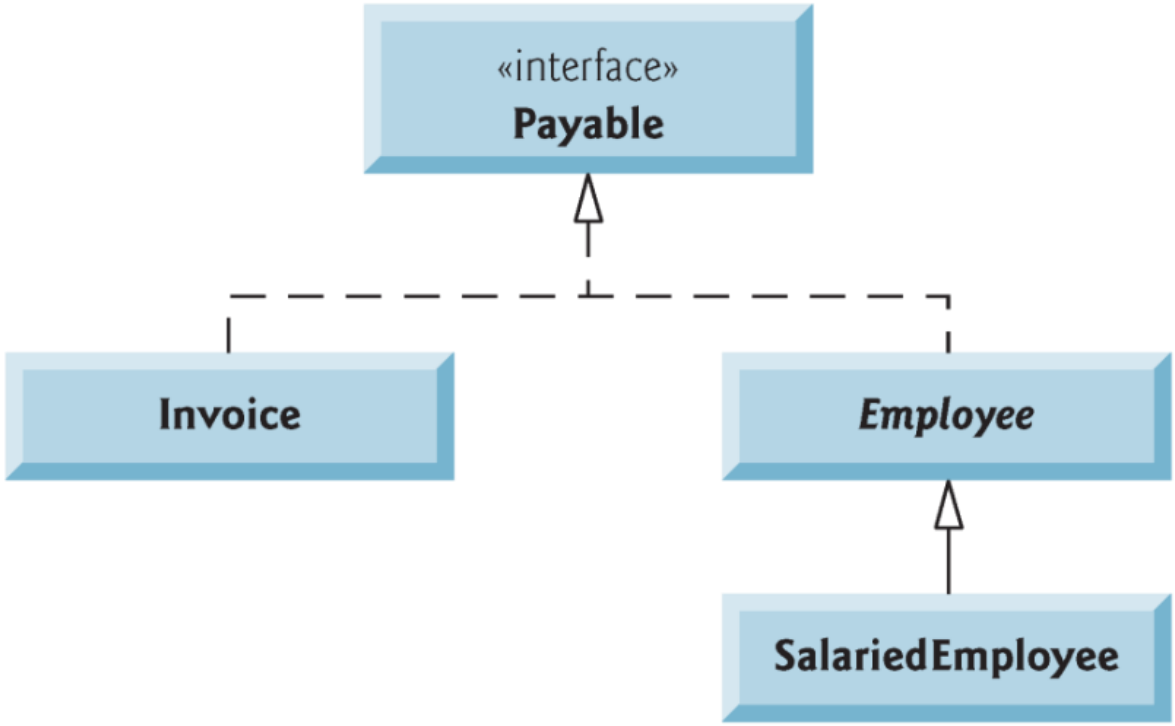
- Idea
  - **Interfaces** are used to define a set of common properties and methods that must be implemented by **classes not related by inheritance**
  - The interface specifies ***what*** methods a class must perform but does not specify ***how*** they are performed
- Syntax

```
interface SomeInterface {
   fun method1(…): SomeType  // No body
   fun method2(…): SomeType  // No body
}
class SomeClass() : SomeInterface {
  // Real definitions of method1 and method 2
}
```

- Motivation
  - Interfaces enables requiring that **unrelated classes implement a set of common methods**
  - Ensure consistency and guarantee that classes has certain methods
  - Let us make **collections of mixed type** objects that can processed polymorphically

Interface Example

- A finance system has Employees and Invoices
- `Employee` and `Invoice` are not related by inheritance
- But to the company, they are both ***Payable***



Interface Example

Payable.kt

```
interface Payable {
 fun getPayAmount(): Double
}
```

Employee.kt

```
class Employee ( ... ) : Payable {
    ...
    override fun getPayAmount() = salary
    ...
}
```

Invoice.kt

```
class Invoice ( ... ) : Payable {
   ...
   override fun getPayAmount() = totalBill
   ...
}
```

Polymorphism Using interfaces

- A way of coding generically
  - way of referencing many related objects as one generic type
    - Cars and Bikes can both `move()` → refer to them as **`Transporter`** objects
    - Phones and Teslas can both `getCharged()` → refer to them as *`Chargeable`* objects, i.e., objects that implement **`Chargeable`** interface
    - Emplyees and invoices can both getPayAmount() → refer to them as *`Payable`* objects

```
for (payable : payables ) {
    println ( payable.getPayAmount() )
}
```

Abstract Class vs. Interface

- Abstract classes and interfaces cannot be instantiated
- Abstract classes and interfaces may have abstract methods that must be implemented by the subclasses
- Classes that implement an interface **can be from different inheritance hierarchies**
  - An interface is often used when unrelated classes need to provide **common properties and methods**
  - When a class implements an interface, it establishes an ***IS-A*** relationship with the interface type. Therefore, interface references can be used to invoke polymorphic methods just as an abstract superclass reference can.
- Concrete subclasses that extend an abstract superclass are **all related to one other by inheriting from a shared superclass**
- Classes can extend only ONE abstract class but they may implement more than one interface

Enum class

- Represents an enumeration

```
enum class Gender {
    FEMALE, MALE
}

enum class Direction {
    LEFT, RIGHT, UP, DOWN
}
```

Summary

- Inheritance = “factor out” the common properties and methods and place them in a single superclass

  => Removing code redundancy will result in a smaller, more flexible program that is easier to maintain.

- Interfaces are contracts, can’t be instantiated
  - force classes that implement them to define specified methods
- Polymorphism allows for generic code by using superclass/interface type variables to manipulate objects of subclass type
  - make the client code more **generic** and ease extensibility

Kotlin Resources

- Kotlin docs
  - https://kotlinlang.org/docs/home.html
  - https://kotlinlang.org/docs/learning-materials-overview.html
- Kotlin online courses
  - https://www.coursera.org/learn/kotlin-for-java-developers
  - https://www.udacity.com/course/kotlin-bootcamp-for-programmers--ud9011
- Kotlin learning resources
  - https://developer.android.com/courses/kotlin-bootcamp/overview
  - https://codelabs.developers.google.com/kotlin-bootcamp/
  - https://kotlinlang.org/docs/reference/